

*DIVISION 8*  
*STORM & SANITARY SEWERS*

**8.01 STORM SEWERS, CATCH BASIN LEADS, AND EXTENSIONS**

**8.01.01 Description**

This work shall consist of installing lines of storm sewer pipe of the required inside diameter, and the necessary appurtenances, for the conveyance of storm water; laid in a trench and shall include excavation and backfilling.

**8.01.02 Structures**

a. Gas and Water Services

Gas and water services crossing the trench which the Contractor may desire to have removed during the trenching operations, shall be moved and replaced at his expense. The work of removing and replacing services shall be done by the City Water Department and Consumers Energy at the Contractor's request. The Contractor must give the Water Department reasonable notice in advance if they wish this service. For any gas or water service crossing the trench which passes through the space occupied by the completed structures, (See 1.04.06 c.).

b. The Contractor shall assume full responsibility for all sewer laterals.

Any lateral damaged by him in the course of construction shall be re-laid and the lateral left in as good a condition as it was before being damaged with the following exception. In case the grade of any sewer lateral has to be changed in order that the sewer lateral may pass over or under the storm sewer, the Contractor shall notify the Engineer and the City will change the grade of the sewer lateral and reconnect said sewer at the City's expense, (See 1.04.06 c.).

c. Miscellaneous Structures

The Contractor shall assume full responsibility for all miscellaneous structures such as telephone or electric wires and cables, poles, trees, walks and driveway culverts. These and any other structures damaged by him in the course of construction shall immediately be repaired.

**8.01.03 Gas Mains, Water Mains, and Sanitary Sewer Mains**

Wherever gas mains, water mains, sewers, etc., cross the sewer trench, Class B Concrete shall be used for backfill beneath them. This backfill shall extend from the bottom of the trench up to within two inches of the bottom of the pipe crossing the trench. A rough wooden form shall be used to hold the concrete in place.

The thickness of the backfill shall be six inches greater than the outside diameter of the crossing pipe. After concrete has hardened, wood blocking shall be placed between the concrete backfill and the crossing pipe to support the pipe until the earth backfill consolidates. Payment for work shall be included in the unit price bid per lineal foot of sewer.

**8.01.04 Underground Structures**

The City Engineering Department has shown the alignment of known underground pipe lines, sewers or structures on the sewer plans. However, some of the locations are uncertain, and the City does not assume the responsibility for locations shown or omissions of pipe lines, sewers or structures on the plans.

**8.01.05 Barricades, Flares, Etc.**

The Contractor shall furnish flares, barricades, warning signs, and place them, at the direction of the Engineer on the job and at such places as to protect the public at all times from injury during the progress of the work. Any expense involved in furnishing this protection shall be borne by the Contractor, (See 1.05.13).

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**8.01 STORM SEWERS, CATCH BASIN LEADS, AND EXTENSIONS (Cont'd.)**

**8.01.06 Materials**

Storm sewer pipe and catch basin leads shall be furnished by the Contractor unless otherwise provided.

- a. Non-reinforced Concrete Pipe for Storm Sewer Mains  
(Six inch through 24 inch) Concrete Pipe shall be tongue and groove meeting the A.S.T.M. Specifications C14 standard strength or extra strength as specified on the plans.
- b. Reinforced Concrete Pipe for Storm Sewer Mains  
(Twelve inch and greater) Concrete Pipe shall be tongue and groove and shall meet the A.S.T.M. Specifications C76 Classification as shown on the plans.
- c. Non-Reinforced Concrete Pipe for Catch Basin Leads  
Concrete pipe shall be bell and spigot and shall meet the A.S.T.M. Specifications C14 standard strength or extra strength as specified on the plans.
- d. PVC Pipe for Catch Basin Leads  
PVC pipe shall be bell and spigot and shall meet A.S.T.M. specification D1785 for Schedule 40 or A.S.T.M. 3034 for SDR 35.
- e. Portland Cement  
Portland Cement shall conform to the requirements for Type I of the current specifications for Portland Cement A.S.T.M. Designation C150.
- f. Masonry Sand  
Masonry sand shall meet the physical and grading requirements of Masonry Sand 2 NS according to MDOT Specifications.
- g. Mortar  
\*\*\*See 8.08.05 e.\*\*\*
- h. External Joint Wrap  
The external joint wrap shall be MIRAFI 140 as manufactured by the Celanese Corporation or TREVIRA SPUNBOUND Style 11/150 as manufactured by ARMCO, Inc.
- i. Sand Backfill  
The Contractor shall furnish suitable sand for backfilling trench which shall consist of clean hard granular sand free from clay, loam or other foreign matter. Not more than seven percent by weight of this material shall pass a #200 mesh sieve.

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**8.01      STORM SEWER, CATCH BASIN LEADS, AND EXTENSIONS (Cont'd.)**

**8.01.07      Construction Methods**

a. Excavation

All earth excavation shall be by open cut from the surface beginning at the outlet and proceeding toward the upper end, true to the line and grade required. The trench shall be of sufficient width to provide free working space and to permit ramming and compacting the backfill around the pipe, but the width shall not exceed the outside diameter of the barrel of the pipe plus six inches on each side, except that a width of less than 27 inches will not be required. When trenches are excavated wider than the above specified widths, caused by the use of power equipment, lack of bracing or other reasons, any increase in cost of excavation, backfill or other items caused by the excessive width, shall be borne by the Contractor.

Where the depth of the trench or the soil conditions require bracing, the sides of the trench shall be sheeted, shored and braced adequately to prevent sliding or caving. The bottom of trenches in earth shall be carefully excavated and graded by hand to the line and contour having a radius at least two inches (2") greater than the outside radius of the sewer pipe as shown on the plans. The excess depth shall be backfilled with sand or sand gravel which shall be compacted and carefully graded so that the barrel of the pipe will be firmly supported throughout its entire length. Recesses shall be excavated to receive the bells. If the storm sewer trench is located within the area of the proposed pavement, all clay soil which is excavated from the trench shall be hauled away and disposed of by the Contractor. All backfill used in the sewer trench which is located within the area of the proposed pavement, is to be sand backfill material.

b. Laying Sewer Pipe

The pipe shall be carefully laid in the prepared trench, groove ends up grade, with tongue ends fully entered into the adjacent groove with each section of pipe having a firm bearing throughout its entire length and true to the line and grade required. Line and grade shall be continually monitored through use of approved laser beam equipment supplied by the Contractor.

Tongue and groove joints shall be made with an approved mastic or plastic joint material. Joint material shall be placed in the groove end of the pipe in proper position and of sufficient quantity to completely seal the joint, excepting that at the bottom of the pipe a section of joint six inches long shall be left unsealed. When the pipes have been properly jointed, the joint shall be completely covered with crushed stone or crushed gravel around the full circumference of the pipe and to a minimum thickness of six inches.

The Contractor may, at his option, provide an external joint wrap in lieu of the crushed stone called for above. The external joint wrap shall be MIRAFL 140 as manufactured by the Celanese Corporation or TREVIRA SPUNBOUND Style 11/150 as manufactured by ARMCO, Incorporated. The joint wrap shall be provided in strips of two (2) foot widths and shall be of sufficient length to provide for one (1) foot overlap. The external wrap shall be positioned firmly about the joint and held in place by sand, carefully laid against the wrap, or by a sufficient quantity of joint mastic to achieve the same purpose. The external wrap shall be in contact with pipe around the entire circumference, and care shall be taken in backfilling so as to avoid disturbing the wrap.

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**8.01 STORM SEWER, CATCH BASIN LEADS, AND EXTENSIONS (Cont'd.)**

**8.01.07 Construction Methods (Cont'd.)**

c. Laying Catch Basin Leads

Catch basin leads shall be carefully laid in trenches prepared in accordance with the plans, in reasonably close conformance with the line and grades shown on the plans or established by the Engineer. Joints between sections shall be as tight as practicable and each section shall have a firm bearing throughout its length. Bell and spigot joints shall be made with a sufficient quantity of mortar to completely seal the joint. External joint wrap shall be positioned firmly around the joint and held in place by sand, carefully laid against the wrap. The external wrap shall be in contact with the pipe around the entire circumference, and care shall be taken in backfilling so as to avoid disturbing the wrap. The joint wrap shall be provided in strips of two foot (2') widths and shall be sufficient length to provide for a one foot (1') overlap.

When PVC pipe is used for catch basin leads, a gasket seal shall be placed around the pipe at the connection to the manhole and catch basin lead in order for a water tight seal to be made between the mortar and the pipe. This gasket shall be a "FERNCO" concrete manhole adapter, a "PRESS-SEAL" WS-RS "Stretch on Gasket" or approved equal.

d. Stone Refill

In water sand or muck that is, in the opinion of the Engineer, unstable, the Contractor shall excavate below the trench bottom and refill with crushed stone, slag, or crushed gravel equivalent in grading to Michigan Department of Transportation specification No. 6A. Where refill is ordered by the Engineer, the Contractor will be paid at the contract unit price per cubic yard, computed according to the following chart:

<u>Nominal Pipe Size</u>	<u>Cubic Yards per Station</u>
8"	7
10"	7
12"	7
15"	8
18"	10
24"	13

The contract unit price per cubic yard for stone refill shall include the additional excavation and the refill material.

e. Branch Connections

Provisions for making existing live sewer connections shall be made at points shown on the plans or as directed by the Engineer. For reinforced concrete pipe sewers the opening shall be cast or cut in the sewer wall of sufficient size to receive the branch pipe.

In cases where connections are to be made to vitrified clay pipe sewers the Contractor shall furnish and build into the sewer wye branches of the required size.

All branches which will not have other pipe connected to them immediately shall be closed by the use of a vitrified clay stopper set in the bell using plastic roofing cement as shown on the plans.

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**8.01      STORM SEWER, CATCH BASIN LEADS, AND EXTENSIONS (Cont'd.)**

**8.01.07      Construction Methods (Cont'd.)**

f. Sewer Taps

When connecting to existing sewers where there is no opening in the existing pipe at the point of connection, an opening shall be cored into the pipe of sufficient size to permit the installation of a "PREDCO" Fast Fit Saddle or approved equal. Following installation of the saddle, the pipe, with its gasket shall be inserted into the saddle in accordance with the manufacturer's recommendations or specifications. In place of cutting in a saddle, the Contractor may replace an existing section of storm main with a precast wye branch using "FERNCO" rubber couplings to seal the joints as a means for tapping into a storm main.

g. Backfilling

All storm sewers located within the area of the proposed pavement shall be completely backfilled with sand as specified. Sand backfill material shall be placed on sections of the sewer only after such sections have been approved by the Engineer for backfilling. Sand backfill material shall be carefully placed by hand under and around the pipe until the pipe is completely covered to a depth of at least one foot. This portion of the backfill shall be placed in layers not more than six inches in thickness and each layer thoroughly compacted without displacing the pipe.

The balance of the trench shall then be backfilled with sand in layers not to exceed 23 inches thickness and each layer compacted to not less than 95 percent of the maximum unit weight at optimum moisture. The method of compaction shall be approved by the Engineer.

Storm sewers not located in roadways will require sand backfill at least one foot above the top of the pipe. The remainder of the required backfill may consist of native material.

h. Cleanout

All new or relaid sewer shall be cleaned of any and all accumulations or silt, debris, and other foreign materials, and shall be free from such accumulations at the time of acceptance. If deemed necessary the Engineer may require the sewer cleaned by the City's sewer cleaning machines at the Contractor's expense.

i. Cleaning Up

Upon completion of the actual work of construction the Contractor shall clean up and leave in a neat condition all the premises which he has occupied during the construction period. Before the final estimate is paid the Contractor shall remove all surplus excavation, debris, rubbish, tools, and equipment from the premises to the satisfaction of the Engineer.

**8.01.08      Method of Measurement**

Sewers shall be measured by the lineal foot of sewer from center to center of manholes, catch basins, and inlet connections shall be measured in lineal feet from center of manhole to center of catch basin or inlet.

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**8.01**      **STORM SEWER, CATCH BASIN LEADS, AND EXTENSIONS (Cont'd.)**

**8.01.07**    **Construction Methods (Cont'd.)**

**8.01.09**    **Basis of Payment**

Sewers shall be paid for on the basis of contract unit price per lineal foot of sewer, which price shall include furnishing materials, excavating, laying of pipe, backfilling the entire trench with sand, hauling away excess material and building the sewer complete as required. All catch basin and inlet connections shall be paid for on the basis of Contract unit price bid per lineal foot of connection, which price shall include furnishing materials, excavating, laying of pipe, backfilling the entire trench with sand, hauling away excess material and building connections complete.

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**8.02      UNDERDRAINS**

**8.02.01    Description**

This work shall consist of constructing underdrains, including excavation, stone fill or filter cloth, and backfill.

**8.02.02    Construction Methods**

Underdrains shall be carefully laid in trenches prepared in accordance with the plans, in reasonably close conformance with lines and grades shown on the plans or established by the Engineer. Joints between sections shall be as tight as practicable and each section shall have a firm bearing throughout its length. The upgrade ends of all drains shall have a suitable plug to prevent entry of soil or other foreign material.

The pipe shall be laid with the holes or perforations on the horizontal plane.

Backfill shall not be placed on sections of underdrain before inspection and approval by the Engineer. Sand fill placed under and around the drain to six (6) inches above the pipe shall be 2NS sand as specified in the "Standard Specifications for Construction", as published by Michigan Department of Transportation.

**8.02.03    Materials**

The Contractor shall furnish all underdrain materials including pipe, jointing materials, stone and filter cloth.

The pipe and fittings used shall be corrugated smooth interior pipe such as Hancor Hi-Q, ADS N-12 or approved equal meeting requirements for test methods, dimensions, and markings as found in AASHTO Designations M-252 and ASTM F-405.

**8.02.04    Method of Measurement**

Underdrains shall be measured by the lineal foot.

**8.02.05    Basis of Payment**

Underdrains shall be paid for at the contract unit price bid per lineal foot, which price shall include furnishing materials, excavating, laying pipe, backfilling and hauling away excess materials and building the underdrain complete as specified.

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**8.03      SANITARY SEWERS**

**8.03.01    Description**

This work shall consist of installing lines of sewer pipe of the required inside diameter and the necessary appurtenances for the conveyance of sanitary sewage, industrial waste or storm water; laid in trench, and shall include excavation and backfilling.

**8.03.02    Structures**

a. Gas and Water Services

Gas and water services crossing the trench which the contractor may desire to have removed during trenching operations, shall be moved and replaced at his expense. The work of removing and replacing services shall be done by the City Water Department and the Consumers Power Company at the Contractor's request. The Contractor must give the Water Department reasonable notice in advance if they wish this service. For any gas or water service crossing the trench which passes through the space occupied by the completed structure, (See 1.04.06 c.)

b. Miscellaneous Structures

The Contractor shall assume full responsibility for all miscellaneous structures, such as telephone or electric wires and cables, poles, trees, walks, and driveway culverts. These and any other structures damaged by him in the course of construction shall immediately be repaired. (See 1.04.06 c.)

**8.03.03    Gas Mains, Water Mains, and Sewer Mains**

Wherever gas mains, water mains, or other sewer mains cross the sewer trench, Class B concrete shall be used for backfill beneath them. This backfill shall extend from the bottom of the trench up to within two inches of the bottom of the pipe crossing the trench. A rough wooden form shall be used to hold the concrete in place. The thickness of the backfill shall be six inches greater than the outside diameter of the crossing pipe. After concrete has hardened, wood blocking shall be placed between the concrete backfill and the crossing pipe to support the pipe until the earth backfill consolidates. Payment for this work shall be included in the unit price bid per lineal foot of sewer.

**8.03.04    Underground Structures**

The City Engineering Department has tried to show the alignment of all known underground pipe lines or structures on the sewer plans. However, some of the alignments may not be exact and the City does not assume the responsibility for locations or omissions of pipe lines or structures on the plans.

**8.03.05    Barricades, Flares, Etc.**

The Contractor shall furnish flares, barricades, warning signs, detour signs, etc., and place them at the direction of the Engineer on the job at such places as to protect the public at all times from injury during the progress of the work. Any expense involved in furnishing this protection shall be borne by the Contractor, (See 1.05.13).



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**8.03      SANITARY SEWERS (Cont'd.)**

**8.03.06    Materials**

Sanitary Sewer pipe shall be furnished by the Contractor unless otherwise provided.

a. Vitrified Clay Pipe

Unglazed clay pipe with A.S.T.M. C425 preformed joints shall be used for all sanitary sewers and combined sewers up to and including 12 inches in diameter.

Clay Pipe shall meet the A.S.T.M. Specifications C700-77, and National Clay Pipe Institute Specification ER 4-67.

b. Concrete Pipe

Concrete Pipe with A.S.T.M. C443 preformed joints shall be used for all sanitary sewer and combined sewers over 12 inches in diameter unless otherwise shown on plans.

Non-reinforced concrete pipe (15" and 18") shall meet the A.S.T.M. specification C-14 Standard Strength or Extra Strength as specified on plans.

Reinforced Concrete Pipe (21" and greater) shall meet the A.S.T.M. specification C76 Classification as specified on plans.

c. Truss Pipe (6"-12")

ABS plastic pipe conforming to ASTM D-2680, excepting that minimum heat deflection temperature (ASTM D-648) shall be 180°F, may be used with the specific permission of the Engineer. Joints shall be solvent-weld type and couplings shall be of materials with chemical physical requirements equal to that of the pipe. Bell and Spigot type gasketed joints must meet ASTM D3212.

d. Precast Reinforced Concrete Manholes

Sanitary Manholes shall be precast reinforced concrete meeting the requirements of ASTM C478 specifications. Preformed water-tight joints shall be used to join sections of the precast concrete manhole and shall have "O"-ring seals or premium rubber gasket. Inlet and outlet pipes shall be joined to the manhole with a flexible watertight, gasket-type connection. Said connection shall be "KOR-N-SEAL" as manufactured by National Pollution Control Systems, Inc., or approved equal. Precast manholes shall be furnished with integral bottoms. Manhole steps shall be made of corrosion resistant cast iron or plastic coated steel.

**8.03.07    Construction Methods**

a. Excavation

All earth excavation shall be by open cut from the surface beginning at the outlet end and proceeding toward the upper end true to the line and grade required. The trench shall be of sufficient width to provide free working space and to permit ramming and compacting the backfill around the pipe, but the width shall not exceed the outside diameter of the barrel of the pipe plus six inches on each side, except that a width of less than 27 inches will not be required. When trenches are excavated wider than the above specified widths caused by the use of power equipment, lack of bracing or other reasons, any increase in cost of excavation, backfill or other items caused by the excessive width shall be borne by the Contractor.

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**8.03      SANITARY SEWERS (Cont'd.)**

**8.03.07      Construction Methods (Cont'd.)**

Where the depth of the trench or the soil condition requires bracing, the sides of the trench shall be sheeted, shored, and braced adequately to prevent sliding or caving. The bottom of trenches in earth shall be carefully excavated graded to the line and contour having a depth at least four inches below the outside of the sewer pipe as shown on the plans. This excess depth shall be backfilled with sand or gravel which shall be compacted and carefully graded so that the barrel of the pipe will be firmly supported throughout its entire length. Recesses shall be excavated to receive the bells. The trench backfill for the pipe foundation embedment/initial backfill shall be an appropriate material per ASTM D2321 for flexible pipes or ASTM C12 for rigid pipes. Backfill from 4 inches below the pipe to 12 inches above the top of pipe shall meet MDOT Class II granular material modified so that 100% passes a 1-1/2" sieve. The final trench backfill shall contain no debris, frozen or organic material within two feet of top of pipe.

**b. Laying Sewer Pipe**

All sewer installation shall be completed in accordance with ASTM D 2321 for flexible pipe and ASTM C 12 for rigid pipe. The pipe shall be carefully laid in the prepared trench, bells up grade with the spigot end entered tightly into the adjacent bell, each section of pipe having a firm bearing throughout its length and true to the line and grade required. Line and grade shall be continually monitored through use of approved laser beam equipment supplied by the Contractor. Unless otherwise provided, all joints shall be preformed and shall be demonstrated to be water tight. They shall be inspected before the pipe is laid and no pipe shall be used if either collar shows any void or unfilled space. No jute or other calking material will be permitted. When laying pipe the linings and collars shall be painted with approved lubricant.

**c. Stone Refill**

In water, sand, or muck that is, in the opinion of the Engineer, unstable, the Contractor shall excavate below the trench bottom and refill with crushed stone, slag, or crushed gravel equivalent in grading to Michigan Department of Transportation Specification No. 6A. Where refill is ordered by the Engineer, the Contractor will be paid at the contract unit price per cubic yard, computed according to the following chart:

<u>Nominal Pipe Size</u>	<u>Cubic Yards per Station</u>
8"	7
10"	7
12"	7
15"	8
18"	10
24"	13

The contract unit price per cubic yard for stone refill shall include the additional excavation and the refill material.

**d. Branch Connections**

Provisions for making existing live sewer connections shall be made at points shown on the plans or as directed by the Engineer. Where connections are to be made of vitrified clay pipe sewers, the Contractor shall furnish and build into the sewer "Y" branches of the required size.

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**8.03**      **SANITARY SEWERS (Cont'd.)**

**8.03.07**    **Construction Methods (Cont'd.)**

All branches which will not have other pipe connected to them immediately shall be closed by the use of a vitrified clay stopper set in the bell and held in position by the use of mastic as shown on the plans.

e. Sewer Taps

When connecting to existing sanitary sewer mains where there is no opening at the point of connection, an opening shall be cut into the pipe of sufficient size to permit installation of a "PREDCO" Fast Fit Saddle or approved equal. Following installation of the saddle, the pipe, with its gasket, shall be inserted into the saddle in accordance with the manufacturer's recommendations or specifications. Cost for sewer taps shall be paid at the contract unit price bid per each.

f. Testing

All sanitary sewers shall be subject to a preliminary air test and all sanitary sewers and manholes shall be subject to either an infiltration or exfiltration test prior to acceptance. All labor, tools, materials and equipment required to conduct the above tests shall be furnished by the Contractor. The Engineer, or his representative, will observe the test and verify the results. These tests shall be conducted as follows:

1. Air Test - The air test is to be used as a preliminary test on newly laid segments of sewer. Individual runs between manholes shall be tested but in no case shall the Contractor have three runs in place without testing prior to starting construction of a fourth run. The air test shall not be used on any pipe of a diameter larger than 24".

The air testing procedures shall conform to ASTM standards. For plastic pipe use ASTM F1417, for clay pipe use ASTM C828, and for reinforced concrete pipe use ASTM C924.

The sewer line shall be tested in increments between manholes. The line shall be cleaned and plugged at each manhole. Such plugs shall be designed to hold against the test pressure and shall provide an airtight seal. One of the plugs shall have an orifice through which air can be introduced into the sewer. An air supply line shall be connected to the orifice. The air supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the air pressure in the sewer. The pressure gauge shall have a minimum diameter of 3 1/2 inches and a range of 0-10 psig. The gauge shall have minimum division of 0-10 psig. and an accuracy of +/- 0.04 psig.

The sewer shall be pressurized to 4 psig greater than the greatest back pressure caused by ground water over the top of the sewer pipe. At least 2 minutes shall be allowed for the air pressure to stabilize between 3.5 and 4 psig. If necessary, air shall be added to the sewer to maintain a pressure of 3.5 psig or greater.

Manholes on sewers to be subjected to air tests shall be equipped with a 1/2 inch diameter galvanized capped pipe nipple extending through the manhole, 3 inches into the manhole and at an elevation equal to the top of the sewer pipe. Prior to the air test the ground water elevation shall be determined by blowing air through the pipe nipple to clear it and when connecting a clear plastic tube to the pipe nipple.

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**8.03**      **SANITARY SEWERS (CON'T.)**

**8.03.07**    **Construction Methods (Cont'd.)**

f. Testing (Cont'd.)

1. Air Test (Cont'd.)

The tube shall be suspended vertically in the manhole and the ground water elevation determined by observing the water level in the tube. The air test pressure shall be adjusted to compensate for the maximum ground water level above the top of the sewer pipe to be tested. (Add 0.433 psig for each foot of ground water, using the average water depth at the manhole at each end>) After all tests are performed and the sewer is ready for final acceptance, the pipe nipple shall be plugged in an acceptable manner.

After the stabilization period, the air supply control valve shall be closed so that no more air will enter the sewer. The sewer air pressure shall be noted and timing for the test begun. The test shall not begin if the air pressure is less than 3.5 psig, or such other pressure as is necessary to compensate for ground water level.

The time in minutes, required for the air pressure to decrease 1.0 psig during the test shall not be less than the time shown in the following table:

Pipe Diameter	<u>Length of Feet</u>					
	<u>10-59</u>	<u>60-84</u>	<u>85-149</u>	<u>150-249</u>	<u>250-349</u>	<u>350-399</u>
4	0.0	0.0	0.5	0.5	1.0	1.0
6	0.5	0.5	1.0	1.5	2.0	3.0
8	0.5	1.0	1.5	2.5	4.0	4.0
10	1.0	1.5	2.0	4.0	5.0	5.0
12	1.5	2.0	3.0	4.5	5.5	5.5
15	2.0	3.0	4.0	7.0	7.5	7.5
18	3.0	4.5	6.0	8.5	8.5	8.5
21	4.0	6.0	8.0	10.0	10.0	10.0
24	6.0	8.0	10.0	12.0	12.5	12.5

Add together the times for each amount of various size pipe to get the total time required.

**NOTE:** The air test can be hazardous under certain conditions. It is extremely important that all air plugs be properly secured and that care be exercised during the test and in the removal of plugs. A 15" plug with 4.5 psi applied to it exerts almost 800 pounds of force. This is an example of the potential hazard that exists if plugs are not correctly installed or are not completely relieved of air pressure before being removed. As a safety precaution it is suggested that pressurizing equipment be provided with a 10 psi pressure relief device to reduce hazards and to avoid over-pressurization of any sewer lines.

2. Infiltration Tests - All sanitary sewers constructed under this contract shall be tested for infiltration. Infiltration tests shall be made by sealing off a section of the sewer and then measuring the infiltration over a definite period of time. Measurements may be made by a weir or by pumping the discharge into measures. Infiltration tests should cover a period of four hours or more. The maximum allowable infiltration shall be 200 gallons per day per inch of inside diameter per mile of sewer.

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**8.03**      **SANITARY SEWERS (Cont'd.)**

**8.03.07**    **Construction Methods (Cont'd.)**

f. Testing (Cont'd.)

3. Exfiltration Tests - Testing for exfiltration shall be accomplished by bulk-heading of a section of the sewer between manholes and filling the sewer and manholes with water to a point four feet below the surface of the ground and measuring the quantity of water required over a four hour period to maintain the water level. The maximum allowable exfiltration shall be 200 gallons per day per inch of inside diameter per mile of sewer.

When infiltration or exfiltration occurs in excess of the specified amount, defective pipe, joints or other places where infiltration or exfiltration occurs shall be located and repaired at the expense of the Contractor. The method used to effect repairs shall be specifically approved in writing by the Engineer.

Should any section of pipe fail to pass the infiltration or exfiltration test, the Engineer may order the Contractor to perform, at the Contractor's expense, a visual inspection of that section of the pipe utilizing closed circuit television techniques. Any visible leaks or cracks in sewers found by using televised inspection shall be repaired regardless of test results.

If defective work cannot be located, the Contractor shall, at his own expense, remove and reconstruct as much of the original work as is necessary to obtain a sewer within the allowable limits.

Infiltration or exfiltration tests shall be performed on lengths of sewer not to exceed 1500 lineal feet.

g. Backfilling

All sanitary sewers located within the area of the proposed pavement shall be completely backfilled with sand as specified. Sand backfill material shall be placed on sections of the sewer only after such sections have been approved by the Engineer for backfilling.

Sand backfill materials shall be carefully placed by hand under and around the pipe until the pipe is completely covered to a depth of at least one foot. This portion of the backfill shall be placed in layers not more than six inches in thickness and each layer thoroughly compacted without displacing the pipe.

The balance of the trench shall then be backfilled with sand in layers not to exceed 12 inches thickness and each layer compacted to not less than 95 percent of the maximum unit weight at optimum moisture. The method of compaction shall be approved by the Engineer. Sanitary sewers not located in roadways will require sand backfill at least one foot above the top of pipe. The remainder of the required backfill may consist of native material.

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**8.03**      **SANITARY SEWERS (Cont'd.)**

**8.03.08**    **Cleanout**

All new and relaid sewer shall be cleaned of any and all accumulation of silt, debris and other foreign material and shall be free from such accumulations at the time of acceptance. If deemed necessary the Engineer may require the sewer cleaned by the City's sewer cleaning machines at the Contractor's expense.

**8.03.09**    **Cleaning Up**

Upon completion of the actual work of construction the Contractor shall clean up and leave in neat condition all the premises which he has occupied during the construction period. Before the final estimate is paid, the Contractor shall remove all surplus excavation, debris, rubbish, tools and equipment from the premises to the satisfaction of the Engineer.

**8.03.10**    **Method of Measurement**

Sanitary sewers shall be measured by the lineal foot of sewer from the center to center of manhole.

**8.03.11**    **Basis of Payment**

Sanitary Sewers shall be paid for at the contract unit price bid per lineal foot of sewer, which price shall include excavating, laying of pipe, furnishing material, backfilling the entire trench with sand, hauling away excess material and building sewer complete as required.

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**8.04**      **LATERAL HOUSE SEWERS (IN R.O.W.)**

**8.04.01**    **Description**

This work shall consist of constructing six inch sanitary and 4 inch storm house sewers, including excavation and backfill, within the right-of-way of any street where detailed on the plans or as ordered by the Engineer.

**8.04.02**    **Materials**

a. Sanitary Sewer Laterals

Sanitary sewer laterals within the right-of-way shall be six inches minimum diameter vitrified clay sewer pipe with A.S.T.M. C-425 preformed joints. Where ABS truss Pipe sewer is allowed, the house lateral sewer may be constructed of ABS-SDR 23.5 sewer pipe (solvent welded joints).

b. Storm Sewer Laterals

Storm sewer laterals within the right-of-way shall be 4 inches minimum diameter Schedule 40 PVC pipe (solvent welded joints) meeting A.S.T.M. D 3034. Lateral connections to the storm sewer main shall be made by an approved factory installed saddle or a field installed "PREDCO" fast fit saddle or approved equal in accordance with the manufacturer's recommendations or specifications.

**8.04.03**    **Construction Methods**

Shall be as specified in Section 8.03.07

**8.04.04**    **Cleaning Up**

Upon completion of the actual work of construction the Contractor shall clean up and leave in neat condition all the premises which he has occupied during the construction period. Before the final estimate is paid the contractor shall remove all surplus excavation, debris, rubbish, tools and equipment from the premises to the satisfaction of the Engineer.

**8.04.05**    **Method of Measurement**

House lateral sewers shall be measured by the lineal foot of sewer from the center of the main sewer to the end of the lateral.

**8.04.06**    **Basis of Payment**

House lateral sewers shall be paid for at the contract unit price bid per lineal foot of lateral, which price shall include excavation, laying of pipe, furnishing materials, completely backfilling trench with sand as specified, hauling away excess material and building house lateral sewer complete.

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**8.06**      **CLEANOUTS FOR SEWERS**

**8.06.01**    **Description**

This work shall consist of building cleanouts over a bend in a sewer of tile the same as specified for the sewer except that the size of tile may be different from that of the sewer; and shall include furnishing materials, excavating and backfilling, at locations shown on the plans or as directed by the Engineer.

**8.06.02**    **Materials**

Vitrified tile (bell and spigot), six inches in diameter shall be used for the vertical section from the top of 45 bend up to the top of the bend for at least a distance of six inches outward from the wye and bend to give lateral backing. Also a cleanout plug will be required to cap the top of tile.

**8.06.03**    **Construction Methods**

This cleanout shall be constructed concurrent with the construction of the sewer. The wye shall be placed in the proper location as the tile is laid for the sewer. The joints shall be made as specified under sewers.

Backfilling shall be done by hand, carefully tamping the material around the cleanout to prevent settlement and breakage. A brass plug will be placed in the top of the uppermost tile.

**8.06.04**    **Method of Measurement**

Cleanouts shall be measured as a unit.

**8.06.05**    **Basis of Payment**

Cleanouts will be paid for at the contract unit price each, which price shall include the excavation, furnishing of all materials, building the item, placing concrete lateral backing, backfilling by hand and entirely completing the work.



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**8.07      PAVEMENT CROSSING FOR SEWER**

**8.07.01      Description**

This work shall consist of supplementing the work of laying a sewer which crosses a pavement by placing concrete lateral backing, carefully tamping sand backfill and replacing the pavement as required by the Michigan Department of Transportation.

**8.07.02      Construction Methods**

Concrete lateral backing shall completely fill the excavated space between the outside of the pipe and the wall of the trench to a height equal to half of the outside diameter of the pipe. Sand backfill of suitable material shall be carefully tamped by hand or machine. Sand shall be placed in layers no more than six inches thick and each layer completely compacted before placing succeeding layers. This procedure will be followed until the backfill is complete. The concrete pavement shall be replaced to its original condition as required by the Michigan Department of Transportation. The Contractor will be required to cooperate with any other Contractor or City Department which may wish to utilize the pavement crossing for another utility.

**8.07.03      Method of Measurement**

Pavement crossings shall be measured as a unit.

**8.07.04      Basis of Payment**

Pavement crossings will be paid for at the contract lump sum price each, which price shall include furnishing of all materials, doing the work as specified, and entirely replacing the crossing to its original condition.

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**8.08**      **MANHOLES, CATCH BASINS, AND INLETS**

**8.08.01**    **Description**

This work shall consist of constructing storm manholes, catch basins, and inlets of concrete, cast in place or precast, concrete block masonry or brick masonry, all with metal frames and covers, and shall include excavation and backfilling.

**8.08.02**    **Materials**

Portland Cement shall conform to the requirements of the current specifications for Portland Cement ASTM Designation C175. Fine aggregate shall meet the MDOT Specification for fine Aggregate No. 2NS. Masonry sand shall meet the MDOT Specification for coarse Aggregate No. 6-A. Water shall be clean and free from injurious amount of oil, alkali, organic matter or other deleterious substances.

Precast concrete manhole pipes, cone and tee sections shall meet all applicable industry standards and ASTM Specification C-478.

Masonry units, including clay brick, concrete brick, concrete block or salvaged paving brick, shall meet the specifications for Masonry units as outlined under the MDOT Standard Specifications for Highway construction.

Castings used in the construction of manholes, catch basins, and inlets shall be Class 30 gray iron castings except cast iron steps which shall be Class 35 unless otherwise specified. All manholes, catch basins and inlet castings will be furnished by the Contractor from an approved source. (see 8.08.04 d.)

**8.08.03**    **Construction Methods**

**Excavation**

Excavation shall be made of sufficient size to permit construction of the base of the structure. Concrete shall not be placed until the depth of excavation has been checked by the Engineer. The excavation may be trimmed to the exact size of the footing and the footing forms omitted where conditions permit and when approved by the Engineer.

Excavation not occupied by the structure shall be backfilled with sand, in layers and each layer compacted to 95 percent of the maximum unit weight at optimum moisture. All surplus excavation shall be disposed of by the Contractor.

**8.08.04**    **Concrete Construction**

Manholes, catch basins or inlets may be built of concrete unless the plans call for a different type of construction. If concrete construction is used, the concrete shall meet the requirements as specified in Division 7 and as shown on the plans.

a. **Forms**

All forms shall be built mortar tight of sound material sufficiently strong and rigid to prevent distortion during the placing and curing of concrete. They shall be built true to the line designated on the plans and shall be securely braced to prevent movement while placing concrete and shall be maintained in this condition until the concrete has sufficiently hardened to permit their removal.

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**8.08**      **MANHOLES, CATCH BASINS, AND INLETS (Cont'd.)**

**8.08.04**    **Concrete Construction (Cont'd.)**

b. Steel Reinforcement

Where steel reinforcement is called for on the plans, the reinforcement shall be properly spaced and held in the correct position during the placing of the concrete.

c. Inlet or Outlet Connections

Pipe or tile inlet or outlet connections called for on the plans shall extend through the walls and beyond the outside surface of the walls in sufficient distance to allow for connection. When required, traps shall be installed as called for on the plans.

d. Castings

All manhole, catch basin, and inlet castings shall be as detailed on the plans and furnished by the Contractor from an approved source. Where manholes are within the paving limits, the final grade shall be set after the bituminous leveling course has been placed.

Standard manhole casting:

EJIW 1040 with Type A Solid Cover

(with 3/4" dia.hole in center of cover

EJIW 1800 with Type A solid Cover

(with 3/4" dia.hole in center of cover

Standard curb-type catch basin casting:

EJIW 7000 with Type M Grate

Non-curb catch basins; in ditch:

EJIW 1040 with Type O Grate

Non-curb catch basins; in parking lot or other paved area:

EJIW 1040 with Type M Grate

24" Tile Catch Basin:

EJIW 1140 with Type O Grate

- e. Wrought iron, galvanized steel or cast iron steps shall be installed where called for on the plans, and as shown on the detailed sheet. Manhole steps shall comply with ASTM C-478.

f. Backfill

The excavated space left after building the structure shall be backfilled with sand in layers not to exceed 12 inches in thickness and each layer compacted to not less than 95 percent of the maximum unit weight at optimum moisture. The method of compaction shall be approved by the Engineer.

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**8.08**      **MANHOLES, CATCH BASINS, AND INLETS (Cont'd.)**

**8.08.05**    **Brick Masonry**

Where this type of construction is used or called for on the plans, the work shall consist of laying brick as required in cement mortar beds and shall include excavation, backfilling, pipe or tile or outlet connections, castings and steps, concrete foundation and completing the construction of the unit. Material specifications have been covered before under 8.08.02.

a. Construction Methods

Base of the structure shall be of concrete as shown on the plans. Concrete shall meet the requirements as previously specified under concrete construction.

The following specifications shall be followed on all brick masonry construction.

b. Preparing and Laying Brick

Before being laid, all brick shall be wetted and the surface dried just enough to prevent slipping of mortar. Brick shall be laid in courses with full and close mortar joints. Courses shall be level unless otherwise specified. Adjoining courses shall break joints by one-half the length of a brick as near as practicable.

c. Joints

Joints shall not be more than 1/2 inch in thickness unless otherwise provided and shall be a uniform thickness throughout the structure. All joints shall be struck and pointed.

d. Plaster Coat

A 1/2 inch plaster coat will be required on the outside of all brick or block structures, and on the inside of structures with sumps, between the outlet and the bottom of the structure.

e. Mortar

Mortar shall be composed of one part of a combination of Portland Cement and hydrated lime and three parts of masonry sand, or one part of masonry cement and two parts of masonry sand by volume. The combination of Portland Cement and lime shall consist of 90 percent of Portland Cement and 10 percent of hydrated lime by volume.

The masonry sand and combination of Portland Cement and lime or masonry cement shall be mixed in a clean tight box, until a mixture of uniform color is produced after which water shall be added in such quantity as to form a mortar of the consistency of stiff paste. Retempering of mortar will not be permitted.

f. Castings

\*\*\*See 8.08.04 d\*\*\*

g. Steps

\*\*\*See 8.08.04 e\*\*\*

h. Backfilling

\*\*\*See 8.08.04 f\*\*\*

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**8.08**      **MANHOLES, CATCH BASINS, AND INLETS (Cont'd.)**

**8.08.06**      **Concrete Block, Construction Methods, Base**

The base of the structure shall be of concrete as shown on the plans. Concrete shall meet the requirements as previously specified under 8.08.04.

The following specifications shall be followed on all concrete block masonry construction.

a. Preparing and Laying Blocks

The first course of blocks as placed on the prepared base or footing shall be on a full bed of mortar. All blocks shall be laid in courses with full and close mortar joints. The courses shall be level throughout, except where otherwise specified. Adjoining courses shall break joints by one-half the length of the block as near as practicable.

b. Joints

Joints shall be of a uniform thickness throughout the structure. All joints shall be struck and pointed, and exposed surfaces shall be true and smooth.

c. Plaster Coat

\*\*\*See 8.08.05 d\*\*\*

d. Mortar

\*\*\*See 8.08.05 e\*\*\*

e. Castings

\*\*\*See 8.08.04\*\*\*

f. Steps

\*\*\*See 8.08.04\*\*\*

g. Backfilling

\*\*\*See 8.08.04 f\*\*\*

**8.08.07**      **Method of Measurement**

Inlets will be measured as a unit. Catch basins will be measured by the vertical foot of depth from the top of the masonry to the bottom (inside) of the catch basin. Manholes will be measured by the vertical foot of depth from the flow line of the sewer to the top of casting at finished grade. Precast tee manhole sections shall be measured as a unit from the flow line of the sewer to the top of the precast tee section. From the top of the precast tee section to the top of the casting at the finished grade shall be measured by the vertical foot of depth.

**8.08.08**      **Basis of Payment**

Inlets will be paid for at the contract unit price each, which price shall include the excavation, furnishing of all materials, building the structure, setting the casting, backfilling and entirely completing the structure.

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**8.08**      **MANHOLES, CATCH BASINS, AND INLETS (Cont'd.)**

Manholes will be paid for at the contract unit price per vertical foot of depth. Precast tee section manhole will be paid for at the contract unit price each, and the additional distance from the top of the precast tee section to the top of the casting will be paid for at the contract unit price per vertical foot of depth of manhole. The above prices shall include excavation, furnishing of all materials, building the structure, setting the casting, backfilling and entirely completing the structure.

Catch basins will be paid for at the contract unit price per vertical foot of depth, which price shall include the excavation furnishing of all materials building the structure, setting the castings, backfilling with sand and entirely completing the structure.

**8.08-5**

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**8.09**      **REBUILDING AND REGRADING MANHOLES**

**8.09.01**    **Description**

This work shall consist of excavation, rebuilding and regrading manholes with brick masonry or approved adjust to grade casting, setting frame and cover to required grade and backfilling.

**8.09.02**    **Materials**

As specified in 8.08.02

**8.09.03**    **Construction Methods**

a. Excavation

Excavation shall be of a sufficient size and depth to permit rebuilding of the manhole to the standard shape and size as shown on the plans.

b. Rebuilding Manholes

The upper part of the existing manhole shall be removed to such a depth that the manhole can be rebuilt to the required elevation and to the standard size and shape shown on the plans, except that bottle necking of the throat of the manhole up to 12 inches in depth will be allowed.

Unless otherwise specified the existing cover shall be replaced in full mortar beds and adjusted to the required elevation as shown on the plans.

Under this item the contractor may, with the approval of the City Engineer, furnish and install an approved adjustable extension to the manhole casting for the purpose of elevating and supporting the manhole cover at the correct road grade.

Where new covers are called for on the plans, or authorized by the Engineer, the covers will be paid for separately.

c. Preparing and Laying Brick

\*\*\*See 8.08.05 b\*\*\*

d. Joints

\*\*\*See 8.08.05 c\*\*\*

e. Plaster Coat

\*\*\*See 8.08.05 d\*\*\*

f. Mortar

\*\*\*See 8.08.05 e\*\*\*

g. Castings

\*\*\*See 8.08.05 f\*\*\*

h. Steps

\*\*\*See 8.08.05 g\*\*\*

i. Backfilling

\*\*\*See 8.08.05 h\*\*\*

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**8.09**      **REBUILDING AND REGRADING MANHOLES (Cont'd.)**

**8.09.03**    **Construction Methods (Cont'd.)**

j. Cleaning Manholes

The Contractor shall clean out any brick, mortar or debris which may fall own inside the manhole during the operation of "Regrading Manhole", and shall leave the manhole in as clean a condition as it was before starting the work.

**8.09.04**    **Basis of Measurement**

Rebuilding and regrading manholes will be measured as a unit.

**8.09.05**    **Basis of Payment**

Rebuilding and regrading manholes will be paid for at the contract price each, which price shall include the excavation, tearing down and rebuilding of manhole, backfilling, cleaning manhole and completely rebuilding manhole to the required elevation.



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**8.10**      **REGRADEING CATCH BASINS AND INLETS**

This work shall be part of curb and gutter construction unless shown differently on the plans. \*\*\* (See Division 6).\*\*\*

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**8.11**      **FORCE MAINS AND APPURTENANCES**

**8.11.01**    **Description of Work**

The work to be done under this contract consists of construction or installation of sewage force mains and appurtenances. The Contractor shall furnish all of the labor, materials, equipment and tools to do all of the work required in excavating; hauling and laying of pipe and special fittings, setting automatic air release valves, installing cleanouts; backfilling all trenches, tunnels, and holes, reconstructing parts of pavements, curbs, sidewalks, ditches, outlawns, sewers, drains and other utilities removed or damaged during construction of the force main; removing and disposing of all surplus excavation. All such items of work are to be done in accordance with the plans and specifications.

**8.11.02**    **Materials**

The Contractor shall furnish all force main materials including pipe, fittings, air release valves, cleanouts, joint accessories and joint lubricant.

The Contractor shall furnish all miscellaneous materials such as concrete, reinforcing steel, and other materials necessary to the installation of the force main. The cost of all materials to be furnished by the Contractor is to be included in the contract unit prices.

**Pipe - for force mains larger than 12" diameter**

Pipe shall be ductile iron, prestressed concrete cylinder pipe, or polyethylene. Unless otherwise noted, pipe shall be designed for a minimum internal pressure of 100 psi and the trench loading conditions indicated on the drawings and specifications.

**DUCTILE IRON PIPE (DI):**

Ductile iron pipe shall meet the requirements of ANSI Specifications and shall be designed for 150 psi working pressure with mechanical joints or slip-on rubber gasket type joints.

Mechanical joint pipe, fittings and accessories shall conform with applicable requirements of ANSI. Rubber gaskets shall conform to manufacturer's standards.

Fittings for ductile iron pipe shall be ductile iron and may be of the mechanical joint type, or the slip-on type conforming with ANSI Specifications.

Slip-joint pipe and accessories may be Bell-Tite, Fast-Tite, Tyton, or equal, and shall conform with applicable requirements of American Standards and Federal Specifications.

All joint material shall be furnished with the pipe.

All pipe and fittings shall be coated on the outside with a bituminous coating of coal tar varnish or asphalt base paint, one mil thick, at the point of manufacture in accordance with the specifications of the American Water Works Association and interior shall be cement lined, standard thickness in accordance with ANSI Specifications. The spigot ends of all pipe lengths, which have been cut in the field, shall be ground to a smooth surface and painted with two coats of asphaltum metal protective paint.

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**8.11**      **FORCE MAINS AND APPURTENANCES (con't)**

**8.11.02**    **Materials (Cont'd.)**

**DUCTILE IRON PIPE (DI): (Cont'd.)**

Polyethylene wrap shall be provided and installed as part of the force main installation. The wrap shall be 8 mil thick Class "C" (black) polyethylene conforming to AWWA standard specification for Polyethylene Encasement for Ductile Iron Pipe, AWWA C105-72. The wrap shall overlap the joint by 12" to either side and be secured to the pipe with polyethylene adhesive tape. All piping and fittings shall be wrapped and taped.

The purpose of the polyethylene wrap is to isolate the pipe from contact with corrosive environments and no attempt is made for complete sealing to prevent ground water intrusion. The standard backfilling procedure specified in 9.01.15 will provide adequate protection for the polyethylene wrap. The cost for the wrap shall be considered incidental to the unit price bid per lineal foot of water main.

**PRESTRESSED CONCRETE CYLINDER PIPE (PCC):**

Prestressed concrete cylinder pipe shall be on the steel cylinder type and meet the requirements of AWWA. Joints shall be rubber gasket with steel bell and spigot rings. The pipe shall be furnished in 16-foot lengths or as required by the Drawings.

The inside of joints, for pipes 24-inches and larger, shall be completely filled with cement mortar composed of 1 part of cement and 2 parts of sand. A canvas diaper shall be fitted around the outside of the joint and a wet grout consisting of 1 part cement and 1 part sand shall be poured into the diaper to completely fill the outside of the joint. The diapers shall be the manufacturer's standard, shall be furnished with the pipe, and shall be installed in accordance with the manufacturer's recommendations.

The pipe shall be partially backfilled and held in place, prior to the pouring of the grout, in order to prevent movement of the pipe and consequent loosening of the grout mortar bond. Special pipes and fittings for line deflections and branches shall meet the requirements of AWWA with rubber and steel joints. Subaqueous pipe shall be furnished where called for on the Drawings and listed in the Proposal.

**POLYETHYLENE PIPE (PE):**

Polyethylene pipe shall be one pressure class higher than the class required to handle the highest expected operating pressure in the force main.

Fittings shall be Class 150 flanged ductile iron.

Polyethylene pipe shall be made from polyethylene resin compound of the types qualified as PE 3408 by the Plastic Pipe Research Institute Method for the Determination of Hydrostatic Stress except that the density of the base resin shall be within the limits of 0.935 to 0.934 as determined by the method of ASTM D1505.

The term polyethylene resin shall mean a thermoplastic resin composed of molecular units of ethylene (HC=CH) or dimers of the above.

The polyethylene resin compound shall have a resistance to environmental stress cracking as determined by procedure detailed in ASTM D1693 with sample preparation by procedure "C" of ASTM D1928 of not less than 192 hours.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.02**    **Materials (Cont'd.)**

**POLYETHYLENE PIPE (PE): (Cont'd.)**

The pipe to be furnished shall contain rework compound generated only in the manufacturer's own plant from resin compound of the same class and type from the same raw material supplier.

Compliance with the requirements of the above paragraphs must be certified by the pipe supplier.

**Pipe Design -**

Outside diameters of the pipe up to and including 8-inch nominal outside diameter shall conform to I.P.S. standard dimensions. Sizes larger than 8-inches shall conform to International Standards Organization (ISO) recommendation for outside diameters as embodied in ISO Recommendation No. R161. Pipe shall be rated according to its design stress in accordance with the following paragraphs and shall be designed to the SDR-PR (see ASTM D2239) principle in the series of design ratings (P) of 100 psi, 125 psi and 160 psi. The SDR (Standard Design Ratio) shall be defined as:

$$Do/t-1$$

**where:**

Do=maximum outside diameter  
t=minimum wall thickness

This value should be used in all design formula in place of the factor D/t, i.e.,  $P=2S/(SDR)$ .

The design stress (S) shall be 625 psi for all pipe sizes and weights up to 8-inches Series 80 and 710 psi for all pipe sizes and weights of 8-inches Series 100 and larger. In no case shall the wall thickness be less than 0.070-inch. The pipe shall be designed from the modified ISO (International Standards Organization) formula:

$$t=p \ Do/2S+P$$

**where:**

t =wall thickness  
P=pressure rating  
Do=outside diameter  
S=design stress

**Joining Methods -**

**Thermal Butt-Fusion:**

Shipping lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process as described in ASTM D-2657. All pipe so jointed must be made from the same class and type of raw material made by a single raw material supplier. Butt-fusion means the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure. Butt-fusion shall be done under the supervision of the manufacturer or by an experienced technician.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.02**    **Materials (Cont'd.)**

**POLYETHYLENE PIPE (PE): (Cont'd.)**

*Joining, Terminating, or Adapting by Mechanical Means.*

Installation lengths shall be joined by the use of flanged couplings as required or as shown on the Contract Drawings. All flange collars attachment to the polyethylene pipe shall be made from the same type and grade of polyethylene, from the same raw material supplier as the pipe, and shall be butt-fused to the pipe ends. The polyethylene pipe larger than 4-inch nominal diameter shall be adapted to systems or fittings of other materials by means of an assembly consisting of a polyethylene flange collar, butt-fused to the pipe, and a backup flange of either ductile iron, steel, or high silica aluminum alloy. Thickness for carbon steel flanges shall be 3/4 inch, bolt circle and bolt holes shall be made to ASA B-16.1 dimensional. All bolts shall be alloy bolts per ANSI - AWWA C111-A21.11 specification (insulated from the fittings where necessary), with a full face gasket of reinforced black rubber or asbestos-rubber compound. In all cases the bolts shall be drawn up evenly and in line. All bolts shall be rechecked and tightened after the creep period.

In no case shall threaded male or female adaptors of any plastic material be used for adapting polyethylene pipe to systems, fittings, or auxiliary equipment of other materials, or for joining the installation lengths to each other.

**Appurtenances -**

Termination to pumps, tanks, valves, etc., or fittings such as tees, bends, etc., made of other materials shall be by the flanged joints of above. The pipe adjacent to these joints and to joints themselves must be rigidly supported as detailed on the Drawings for a distance of one pipe diameter or 1 foot, whichever is the greater beyond the flange. Appurtenances must be placed on their own foundations, unsupported by the pipe, as shown on the Drawings. Pipe shall be anchored to manholes as detailed on the Contract Drawings.

**Location Wire:**

When polyethylene pipe is chosen, a single #14TW or TH/TW copper wire shall be laid along with the main for location purposes. The wire shall be brought up through and securely fastened at the finished ground elevation inside each structure, including air release valve manholes and valve chambers. Provide cathodic protection by installing a buried anode to protect the wire. The anodes shall be a minimum of 10 pounds each and shall be installed at intervals of 800 feet along the length of the wire.

**Pipe for Force Mains 12" diameter and less**

Pipe shall be ductile iron, polyethylene, or unplasticized polyvinyl chloride (PVC). Pipe shall be designed for internal pressure of 160 psi and the trench loading conditions indicated on the drawings and specifications.

**DUCTILE IRON PIPE (DI):**

Ductile Iron Pipe shall be push-on joint, cement mortar lined, 350# Class 2, in accordance with ASA A21.51 or AWWA C151, and A21.4 standard thickness cement mortar lining.

**POLYVINYL CHLORIDE PIPE (PVC):**

PVC pipe shall be one pressure class higher than the class required to handle the highest operating pressure in the pumping main.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.02**    **Materials (Cont'd.)**

**POLYVINYL CHLORIDE PIPE (PVC):**

PVC pipe shall meet the requirements set by ASTM for materials used and have an SDR number determined by the pipe material and pressure class necessary as specified in ASTM.

Fittings shall be ductile iron of comparable class.

Joints shall be bell and spigot type with a flexible elastomeric gasket conforming to ASTM. Joints shall be made using a lubricant as supplied and as directed by the manufacturer. PVC pipe shall conform in size with fittings of other materials so a mechanical joint can be made with joint restraint as approved by the Engineer. If it is necessary to field cut a standard length of pipe, the new spigot end shall be prepared as recommended by the pipe manufacturer.

After delivery, PVC pipe shall be stored on a flat surface so that the barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet. If the pipe is to be stored for an extended period of time, it shall be covered with an opaque material so it is protected from the sun's rays and the bells shall be inverted in alternate rows so they are not supporting the direct load of the pipe. Deflection of any particular amount of PVC pipe shall not exceed 5%.

Polyethylene pipe in this size category shall meet all of the requirements of polyethylene pipe for force mains larger than 12" diameter as specified earlier in these specifications.

***Location Wire:***

When PVC or polyethylene pipe is chosen, a single #14TW or TH/TW copper wire shall be laid along with the main for location purposes. The wire shall be brought up through and securely fastened at the finished ground elevation inside each structure, including air release valve manholes and valve chambers. Provide cathodic protection by installing a buried anode to protect the wire. The anodes shall be a minimum of 10 pounds each and shall be installed at intervals of 800 feet along the length of the wire.

**8.11.021**    **Automatic Air and Vacuum Valves and Air Release Valves:**

Air and vacuum valves and air release valves shall be placed in dual stack configuration at locations shown on the plans, together with the necessary appurtenances. These valves shall be designed for service up to 150 psi. Valve body shall be cast iron with a Buna N seat and stainless steel float.

The sewage air inlet and vacuum relief valves shall be capable of venting large quantities of air into the force main and shall be furnished with a 4-inch inlet.

The sewage air release valve shall be capable of releasing small pockets of air under pressure and shall be furnished with a 2-inch inlet.

The sewage air release valve shall be capable of releasing small pockets of air under pressure and shall be furnished with a 2-inch inlet.

All fittings necessary for the dual stack configuration as shown on the drawings shall be furnished.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.021**    **Automatic Air and Vacuum Valves and Air Release Valves (Cont'd.)**

The top of the valves shall be fitted with a 1/2-inch shut-off valve; quick disconnect coupling; and a back flushing hose 25 feet in length. The bottom of the valves shall be manufactured by Apco, Crispin, or Permutite, or equal, in the quantity shown and detailed in the Contract Drawings and Documents.

**8.11.022**    **Materials - Clean-Out**

The clean-out shall consist of a wye branch having all diameters the same as the force main, installed with additional piping to extend above the force main to within 12' of the surface. A pressure tight plug or cap, with thrust protection meeting the Engineer's approval, shall be provided at the open end of the additional piping. A 3/4" iron rod shall be driven above the clean-out for location purposes.

**8.11.023**    **Materials - Joint Restraint**

All pipe deflections over 20 degrees, and at all tees shall be restrained, tied or harnessed in a manner acceptable to the Engineer. The restraint shall be applied to joints each way from the deflection or tee an adequate distance to resist the axial thrust of the test pressure. Details of all proposed joint restraint, showing type and locations, shall be submitted to the Engineer for approval. Concrete thrust blocks will be permitted for PVC pipe only.

All joint restraint shall be considered incidental to force main construction.

Acceptable methods of joint restraint:

Concrete Pipe: Lugs and draw bolts (draw bolts galvanized), or bell bolts.

Ductile Iron Pipe: Retainer glands through 24-inch pipe and Super-Lock or Lockfast above 24-inch.

Polyvinyl Chloride Pressure Pipe: Concrete thrust blocks.

Polyethylene Pipe: As recommended by the manufacturer, subject to Engineer's approval.

**8.11.03**    **Excavation**

Installation shall be in accord to 8.03.07. The excavation for the force main shall be done in open trench or in tunnel as herein specified, as shown on plans. All work shall be done to true line and grade as established on the plans, and the line and grade stakes set by the Engineer. The Contractor must protect the line and grade stakes and be held responsible for any defective work occasioned by his negligence in this regard. The Contractor shall remove all rubbish or encumbrances which may be in the proposed line of the force main and the cost for doing such work shall be understood as being included in the price.

A trench width of not less than 20 inches nor more than 26 inches shall be excavated for laying six inch, eight inch, ten inch or twelve inch pipe. For larger sizes of pipe the trench width shall not be less than one and one-half times the diameter of the pipe to be laid. Bell holes shall be excavated at each joint.

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**8.11**      **FORCE MAINS AND APPURTENANCES (CON'T.)**

**8.11.03**    **Excavation (Cont'd.)**

Rock or stones found in the bottom of the trench shall be removed for a depth of at least six inches below the bottom of the pipe and the holes thus created and all other irregularities in the trench bottom shall be filled to grade with sand before the pipe is laid and the cost of doing said work is understood as being included in the price. A 4-inch minimum granular bed shall be provided under the pipe.

All sheeting and bracing necessary, in tunneling or for supporting the sides of the trench and shafts, shall be furnished by the Contractor. Said sheeting and bracing shall be removed by him as the work progresses, and the space occupied by the sheeting, filled solid with earth, sand or concrete as directed by the Engineer. When ordered in writing by the Engineer, that sheeting is to remain in place, it shall be estimated and paid for as an extra at the price agreed upon.

The Contractor shall at his own expense pump out or otherwise remove any water which may gather in the trenches or tunnels, and shall form all dams, cofferdams or other works necessary for keeping the excavated trenches or tunnels clear of water during the progress of the work. In case of quicksand or other bad and treacherous ground, the work shall proceed day and night without intermission, if the Engineer so directs.

When and where portions of the pavement have been disturbed or removed by the Contractor as required under these specifications, the Contractor shall relay the same in accordance with standard specifications for Street Improvement of the City of Midland.

Whenever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plans is required, the Engineer shall have the authority to change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation or reconstruction of the obstructions. If the change in plans result in a change in the amount of work by the Contractor, such altered work shall be done on the basis of payment to the Contractor for extra work or credit to the City for less work.

The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and he shall be held responsible for the repair of such structures when broken or otherwise damaged because of carelessness on his part.

Whenever, in the opinion of the Engineer, it is necessary to explore and excavate to determine the location of existing underground structures, the Contractor shall make explorations and excavations for such purposes. If the Contractor is required to perform additional work in making explorations and excavations, extra compensation will be allowed for such additional work.

**8.11.04**    **Laying Pipe**

After the trench or tunnel has been excavated and the bottom has been graded and prepared, the pipe shall be carefully laid making sure that at least two thirds of the length of the body of pipe is resting firmly on the prepared grade. Blocking under the pipe shall not be permitted. The interior of all pipe and special castings must be thoroughly cleaned by brushing, swabbing and washing out all dirt before laying. All PVC force mains shall be installed in accordance with AWWA C605.



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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.04**    **Laying Pipe (Cont'd.)**

A single #14TW or TH/TW copper wire shall be laid along with PVC or PE Pressure Pipe for location purposes. The wire shall be brought up through and securely fastened at finished ground elevation inside each structure, including air release valve manholes and valve chambers. Provide cathodic protection by installing a buried anode to protect the wire. The anodes shall be a minimum of 10 pounds each and shall be installed at intervals of 800 feet along the length of the wire. The Contractor shall make a continuity test for each section of installed wire.

**8.11.05**    **Blocking Pipe**

All bends, curves, dead ends and special castings shall be blocked with concrete thrust blocks or other method approved by the Engineer. The cost thereof is understood to be included in the price.

**8.11.06**    **Pipe Cutting**

Whenever it becomes necessary to cut a pipe to make a connection or closure in either old or new work, the pipe shall be cut on the shortest outside circumference. The method used for cutting pipe shall be as directed by the pipe manufacturer. Sharp outside edges on pipe ends at cuts shall be ground smooth to prevent damage to the joint gaskets.

**8.11.07**    **Pressure Leakage Test - For Ductile Iron Pipe**

After the entire force main, or any part of the force main located between two gate valves, has been laid, the installed main and appurtenances shall be capable of meeting the requirements imposed by a pressure leakage test given as follows:

The completed pipe line shall be slowly filled with water until all of the air has been expelled. When certain that all the air has been expelled from the pipe line, the water pressure shall be raised by a hand pump to 150 pounds per square inch and shall be maintained at this pressure for a period of at least two hours. The amount of additional water to maintain this pressure shall be taken as the amount of leakage. The pressure on the pipe line shall be determined by a tested pressure gauge equipped with a snubber.

The amount of water used shall be determined by connecting a tested water meter into the pump supply line or in the case of testing a short section of pipe line a container may be used to supply replacement water to the pump and the amount of water calculated by direct measurement.

To have the force main successfully pass the test the indicated leakage shall not exceed 11.65 gallons per day, per inch of diameter, per mile of pipe. If the pipe line does not meet the requirement, the pipe line may be allowed to stand under normal City pressure for from twenty-four hours to three days and the test again repeated. During this time if a joint or joints indicate an undue amount of leakage by either showing up on the surface or by indicated on sound testing equipment, said joint or joints shall be uncovered and repaired before other tests are made.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.07b Pressure Leakage Test - For Polyethylene Pipe**

Pressure testing with air is not recommended for high density polyethylene pipe under any circumstances. Water is the recommended pressure medium for the pressure testing of PE piping systems. Testing may be done before or after the pipe is in the trench. If the pipe must be backfilled before it is tested, the mechanical joints shall be left open for visual inspection during testing.

Basic Procedure for Pressure Testing:

When pressurized, polyethylene pipe exhibits a relatively rapid rate of initial deformation (i.e. unnoticeable radial expansion), followed by a slower, more constant rate of deformation with time. As the pipe expands, the pressure decreases and more water must be pumped into the system to maintain the pressure. If a leak exists in the system, the amount of water required to maintain the pressure will be considerable more than this pre-determined amount of make-up water. The pressure test involves pressurizing the pipe and adding make-up water until the pipe has reached its initial deformation. This level of deformation is usually attained after 3 to 4 hours, depending on the size of the pipe.

It is characterized by a noticeable reduction in the amount of make-up water required to return the piping system to the test pressure. It is at this time that the actual test period begins. Its duration can be 1 to 3 hours. At the end of the test period, a measured amount of make-up water should be added to return the pipe to the test pressure. The amount of make-up water should not exceed the allowance given in Table 8.11-01.

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**8.11      FORCE MAINS AND APPURTENANCES (CONT.)**

**8.11.07b    Pressure Leakage Testing - For Polyethylene Pipe**

**TABLE 8.11 - 01**  
**ALLOWANCE FOR EXPANSION UNDER TEST PRESSURE\***  
Allowance for Expansion (U.S. gal. per 100 feet of pipe) at 73.4 ° F

Nominal Pipe Size (in.)	1 Hour Test	2 Hour Test	3 Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.00	1.50
10	0.70	1.30	2.10
11	1.00	2.00	3.00
12	1.10	2.30	3.40
14	1.40	2.70	4.20
16	1.70	3.30	5.00
18	2.20	4.30	6.50
20	2.70	5.50	8.00
22	3.50	7.00	10.50
24	4.50	8.90	13.30
28	5.50	11.10	16.70
32	7.00	14.30	22.50
36	9.00	18.00	27.00
40	11.00	22.00	33.00

\* These allowances refer to the actual Test Period.

The amount of expansion taking place during the pressure testing of polyethylene pipe is also dependent on the temperature of the pipe during testing. The temperature of the pipe can be taken as an average of the temperature of the water pumped into the pipe and the temperature of the empty pipe immediately before testing (ambient air temperature). When testing the pipe at temperatures be 73.4° F, the amount of make-up water shown in Table8.11-01 should be multiplied by the appropriate correction factor taken from Table 8.11-02.

## **8.11** **FORCE MAINS AND APPURTENANCES (CON'T.)**

**Table 8.11-02**

If agreed to by the City Engineer, pressure testing with water may be conducted after joining is complete, before laying the pipe into the trench. The pipe should be subjected to a hydrostatic test pressure of 1.5 times the rated pressure of the pipe ( $1.5 \times$  the Standard Pressure Rating as obtained from Table 8.03) for a maximum period of 3 hours. The pipe can be maintained at the "Test Pressure" by the periodic addition of make-up water.

**Note:** It is the responsibility of the Contractor to ensure that normal safety precautions are observed for above ground hydrostatic pressure tests.

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**8.11**      **FORCE MAINS AND APPURTENANCES (CON'T.)**

**8.11.07b**      **Pressure Leakage Testing - For Polyethylene Pipe  
(Con't.)**

**TABLE 8.11-03**  
**STANDARD PRESSURE RATING**

Hydrostatic                      Standard Pressure Rating (DR)  
Design                              (psig    73.4° F)  
Basis

	32.5	26	21	17	15.5	13.5	11	9	7.3	6.3
625 psi	40	50	63	78	86	100	125	156	198	236
725 psi	46	58	72	91	100	116	145	181	230	274
800 psi	50	64	80	100	110	128	160	200	254	300

Pressure Testing in the Trench:

After the pipeline has been laid, it can be filled with water and subjected to a hydrostatic pressure test. The "Test Pressure" shall be 50 percent greater than the rated pressure of the pipe at the lowest elevation of the system. When in the opinion of the Engineer, local conditions require that the trenches be backfilled immediately after the pipe has been laid, the pressure test may commence: after the backfilling has been completed and at least 36 hours after the last concrete bearing pad has been cast with high early-strength cement; or at least 7 days after the last concrete bearing pad has been cast with standard cement.

The test procedure consists of two steps: the initial expansion phase and the test period. In order to accommodate the initial expansion of the pipe under test, sufficient make-up water is added to the system at hourly intervals for 3 hours each, returning the piping system to the "Test Pressure." After the completion of the initial expansion phase, (e.g., 4 hours after initially pressurizing the piping system under test) the actual test period will begin. The test period must not exceed 3 hours. After this Test Period, a measured amount of make-up water shall be added to return the piping system to the Test Pressure. The amount of make-up water should not exceed the allowance given in Table 8.11-01.

**NOTE:** Under no circumstances shall the total time under test exceed 8 hours at 1.5 times the pressure rating. If the test is not completed due to leakage, equipment failure or any other reason within this time period, the test section shall be permitted to "relax" for an additional 8 hour period prior to starting the next testing sequence.

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**8.11**      **FORCE MAINS AND APPURTENANCES (Cont'd.)**

**8.11.08**      **Backfilling and Open Trenches**

An acceptable grade of clean sand or fine gravel shall be placed and tamped along the sides of the pipe line up to at least one foot above the top of the pipe for the full width of the trench before any other backfill material is placed over the pipe, and shall be compacted at 90% density. The remaining portion of the trench shall then be backfilled with material excavated; but care shall be given to make sure that all stones, pieces of concrete and other materials which might damage the pipe are not placed in the backfill. Fly ash or cinders shall not be permitted to be used as backfill. When a machine is used to place the backfill material, no material shall be dropped into the trench but shall be placed on the sloping end of completed backfill and allowed to roll in place to the bottom of the trench.

Should any deficiency in the backfilling occur, in either quantity or quality of excavation materials taken from the trench, the Contractor shall supply the deficiency without extra charge to the City. No foreign or perishable material shall be used in the backfilling.

All trenches between the sidewalk line and the shoulder of the road shall be left with a sufficient mound of earth above the original surface, as is deemed necessary by the Engineer, to take care of future settlement.

All backfill in trenches between the shoulders of the roadway or in driveways shall be left not higher than the original surface. All gravel driveways and gravel streets shall be resurfaced to equal the original amount of gravel before construction.

**8.11.09**      **Backfill in Tunnel**

A good grade of clean river sand or concrete sand mixed in the proportions of one sack of Portland Cement to one cubic yard of sand shall be slightly dampened and tamped in and around the pipe and all the way to the roof of the tunnel. Shoring and bracing used to support the tunnel roof shall be removed as the backfill material is tamped in place.

**8.11.10**      **Backfilling under Roadways, Etc.**

Trenches excavated through cuts in existing pavements, curbs, sidewalks, crosswalks, approach walks, all roadway and right-of-ways, shall be backfilled with good clean sand, and compacted to 95% density. When force main is constructed under existing pavement, curb, sidewalk, crosswalk, or in the parkway or lawn area, the Contractor, at his own expense, shall for a period of one year from the payment of the final estimate make additional fills wherever settlements have taken place and restore the pavements, curbs, lawns, and other public fixtures wherever settlement or displacements have taken place, along the line of work. The cost of furnishing materials and making backfill in tunnel or in cuts through existing structures shall be understood to be included in the unit price bid for force main.

**8.11.11**      **Surplus Earth**

Surplus earth is understood to mean the excess of earth excavated and remaining after the required backfill hereinbefore specified is completed.

The unexcavated portions of the roadway surface shall be left in its original condition, graded free of any clay deposits. All ditches shall be cleaned to grade set by the Engineer. No surplus earth will be left in the road ditches except by permission of the Engineer. If such permission is granted the earth shall be graded in accordance with grade stakes set by the Engineer.

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**8.11**      **FORCE MAINS AND APPURTENANCES (CON'T.)**

**8.11.12**    **Method of Measurement**

Measurement of force main laid will be made in lineal feet on the axis of the pipe laid from the beginning to the end and shall include measurements through special castings and valves.

**8.11.13**    **Basis of Payment**

Force main will be paid for at the contract unit price bid per lineal foot for the size pipe laid, which price shall be payment in full for furnishing the necessary materials as specified, excavating, laying, blocking, testing, backfilling, cleaning up, grading and completing the main all in accordance with the specifications.